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Final Report for the Galena Gulch  
Prescribed Fire Demonstration Project;  
Fire Effects and Postburn Evaluation of  
Results in East-side Shrub/Grass  
Communities of the Douglas-fir Habitat  
types

Final Report for the Galena Gulch Prescribed Fire  
Demonstration Project; Fire Effects and Postburn  
Evaluation of Results in East-side Shrub/grass  
Communities of the Douglas-fir Habitat Types.

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## Executive Summary

A cooperative study was established involving the Deerlodge National Forest, Intermountain Fire Sciences Laboratory and Systems for Environmental Management, Inc. This study was conducted to examine and improve upon the operational applications of prescribed fire to the east-side shrub/grass communities of the Douglas-fir habitat types. National Forests east of the continental divide in USFS Region 1 recognized that additional information was necessary to successfully implement their proposed fire management plans within plant communities of these types.

A study area was established in the Galena Gulch drainage on the north end of the Jefferson Ranger District. Several potential treatment situations were described and subsequently mapped. An interdisciplinary team evaluated the drainage and developed a long-range prescribed burning plan based on resource objectives and what could be achieved by a combination of management strategies. The Intermountain Fire Sciences Laboratory and Systems for Environment Management, Inc. completed a more intensive review of the fire history, vegetational changes, and potential treatment situations within the drainage and surrounding areas which are documented elsewhere. This report summarizes vegetal changes and the achievement of objectives on several of the treatment units early in the project. Most of the changes observed were attributable to the prescribed fire treatments. Where changes were not believed due to the treatment, but to other natural phenomenon, the causes were noted.

The first two burns were completed during the spring of 1983 in sagebrush/grass parks with Douglas-fir encroachment (Unit 1b). Transects had been previously established within these units to monitor vegetal trends following burning, and to help determine if the land management and fire objectives were being successfully met. It was determined that the objectives had been met by these management fires. Conifer and sagebrush encroachment were curtailed. Minimal mortality was experienced by the predominant grass species, and herbaceous production was substantially increased. Unanticipated results following the burning included the rapid reestablishment of mountain big sagebrush seedlings, and the rapid biomass increase and peak of Richard's needlegrass.

Two areas (Unit 2a) composed of very different habitat types and requiring different management strategies were burned in the fall of 1984. The first unit burned was predominately dense mature Douglas-fir and lodgepole pine with very little surface fuel. This site was clearcut and the remaining slash distributed over 25 acres of the 30 acre site to help carry the fire. Objectives to be accomplished on this unit included the rejuvenation of associated aspen stands, the development of a mineral soil seedbed for establishment of early successional shrubs and trees, and the reduction of the post timber harvest fuel hazard. Walk-through evaluations immediately after the fire, then again one year later concluded that it was likely that all objectives had been met by this fire except for the aspen rejuvenation. It is recommended that future burns with aspen regeneration as an objective be conducted sooner after the mature aspen has been cut than was done with this unit. Also larger areas of treated acreage must be available for better livestock and wildlife dispersal to minimize early

utilization damage. Especially pronounced was the response of evergreen ceanothus which was not evident on the preburn site. One year after the prescribed fire ceanothus seedlings had densities estimated at 100,000 seedlings per acre on portions of the burn.

The second unit burned during the fall of 1984 was sagebrush/grass parks with areas of very dense Douglas-fir encroachment. These dense encroachment areas were heavily infected by western spruce budworm. Elimination of the sagebrush and Douglas-fir encroachment were the major objectives on this 110 acre unit. The mortality of Idaho fescue was also to be kept to less than 25%. Within the sagebrush/grass parks the encroachment objectives were met by the prescribed fire treatment. Idaho fescue mortality was high only in areas of disturbance by fireline construction or extensive mop-up activity. Within the dense Douglas-fir encroachment areas the fires burned with a low intensity and occasional canopy torching. The fire did not meet the encroachment objectives within these portions of the unit. However, most of the Douglas-fir in these areas were dead the season after the fire due to the western spruce budworm.

These results from the four units burned (out of a total of 21 units scheduled in the project) have shown some of the benefits and problems that can be achieved with using prescribed fire in the east side Douglas-fir habitat types. The initial benefits indicate that prescribed fire can be successfully used to help implement management goals to improve range and wildlife habitat. Problems that have arisen can be easily rectified on future areas with limited additional training of fire personnel and closer coordination with other associated management strategies such as grazing and small timber sales.

## Introduction

A cooperative study involving the Deerlodge National Forest, the Intermountain Fire Sciences Laboratory (IFSL) and Systems for Environmental Management, Inc. (SEM) was conducted to examine and improve upon the operational application of prescribed fire to the east-side shrub/grass communities of the Douglas-fir (Pseudotsuga menziesii) habitat types (Pfister et al. 1977). Forest Plans on the Beaverhead, Deerlodge, Gallatin, Helena, and Lewis and Clark National Forests call for relatively large acreages of land in these habitat types to be treated on a periodic basis by prescribed fire. A number of deficiencies, or unanswered questions were recognized by the Forests that hampered their proposed fire management plans, these included;

- 1) a lack of information on how to identify prescribed fire opportunities,
- 2) a lack of site selection criteria for prescribed burning,
- 3) what were the effects of various burning prescriptions,
- 4) what are appropriate acreages to be burned by the Forest programs,
- 5) what would be the program level benefits.

This cooperative study was established to investigate areas 1 through 3 of the above problems. Insight into areas 4 and 5 might also be provided; but the political, social and budgetary impacts of the proposed programs make answers to these questions beyond the scope of this study.

With these problems in mind a broad range of objectives were designed that would provide data to ecological questions as well as improve the overall east-side Forests prescribed fire capabilities. Much of the project was to demonstrate and document the beneficial use of fire in the reduction of conifer and sagebrush encroachment, the ability to rejuvenate decadent aspen (Populus tremuloides) clones, and to increase herbaceous productivity within Douglas-fir stands. Information was to be gathered that would aid development of a series of guidelines that would help fire managers to achieve wildlife and range land management objectives. Also, a cadre of trained prescribed fire burners would be developed during the project that could implement the Forests prescribed fire plans.

## Planning Process

The east-side Forests in USFS Region 1 recognized an ecological development that had occurred on lands, not only under their jurisdiction, but throughout the entire area. This development is the natural vegetational succession that results on these forest/grassland ecotonal lands from a lack of periodic perturbation, in this case primarily fire. Studies in Montana of tree ages (Arno and Gruell 1983, 1985); reviews of historical photographs (Gruell 1983); and comparisons of early (1878) vegetation patterns, structural and composition features compared with current features (Bushey, unpublished data), indicate that a significant migration of conifers into former grasslands has occurred and that the forests themselves have become more dense. Near the lower timberline, young conifer stands now occur on sites previously having few or no mature trees. Dead sagebrush is often found beneath these new

forest stands, indicating their former grassland status. In moister areas, patches of aspen have been shaded out by the increase in fire intolerant conifers. Other aspen stands are in a weakened condition and are declining rapidly due to increased age, disease, and competition induced stress. The increase in conifer cover and needle duff has also resulted in a corresponding decrease in forage plants. The reduced forage base has contributed to increased competition, and conflict, for managed forage between livestock and wildlife in many areas.

Before settlement by Euro-americans much of this area had a reoccurring fire frequency of approximately 35-40 years (Arno and Gruell 1983). These wildfires kept the vegetation in an early stage of succession. Cultural practices following settlement such as road building, cultivation, irrigated pastures, and livestock forage consumption broke up the fuel bed continuity that formerly allowed fires to spread over wide areas.

Recognition of the implications of the successional changes taking place, and the need for treatment of conifer encroached grasslands in the Douglas-fir habitat types led to the establishment of a prescribed fire demonstration area in Galena Gulch, Jefferson Ranger District, Deerlodge National Forest (Figure 1). Initially the Forest conducted an evaluation of their conifer encroachment problem broken down by drainage basins. The Galena gulch drainage was selected from a final list of three candidate areas. The Galena Gulch area was typical of successional developing east-side Douglas-fir habitat types. The site varies in elevation from 5,400 feet in Kilborn Gulch to 6,400 feet in Big Galena Park. The area has mostly skeletal soils, with occasional deeper colluvial soils over decomposed granitic substrate of the Boulder batholith. The area is mostly a series of gently sloping grass or sagebrush/grass covered ridges with some timbered drainages. Smaller sagebrush/grass openings are interspersed within the Douglas-fir and lodgepole pine (*Pinus contorta*) forested areas. The area supports livestock, elk, and mule deer grazing.

Four treatment situations were identified, then broken down into 21 individual treatment units and scheduled by an interdisciplinary team for spring or fall prescribed burning through 1988. This team consisted of Prescribed Fire Managers, Foresters, Wildlife Biologists, Range Conservations, and Fire Effects Researchers. The treatment situations were based essentially on differences resulting from various successional stages and vegetal structure, and their preconceived response to a fire treatment. These four situations were;

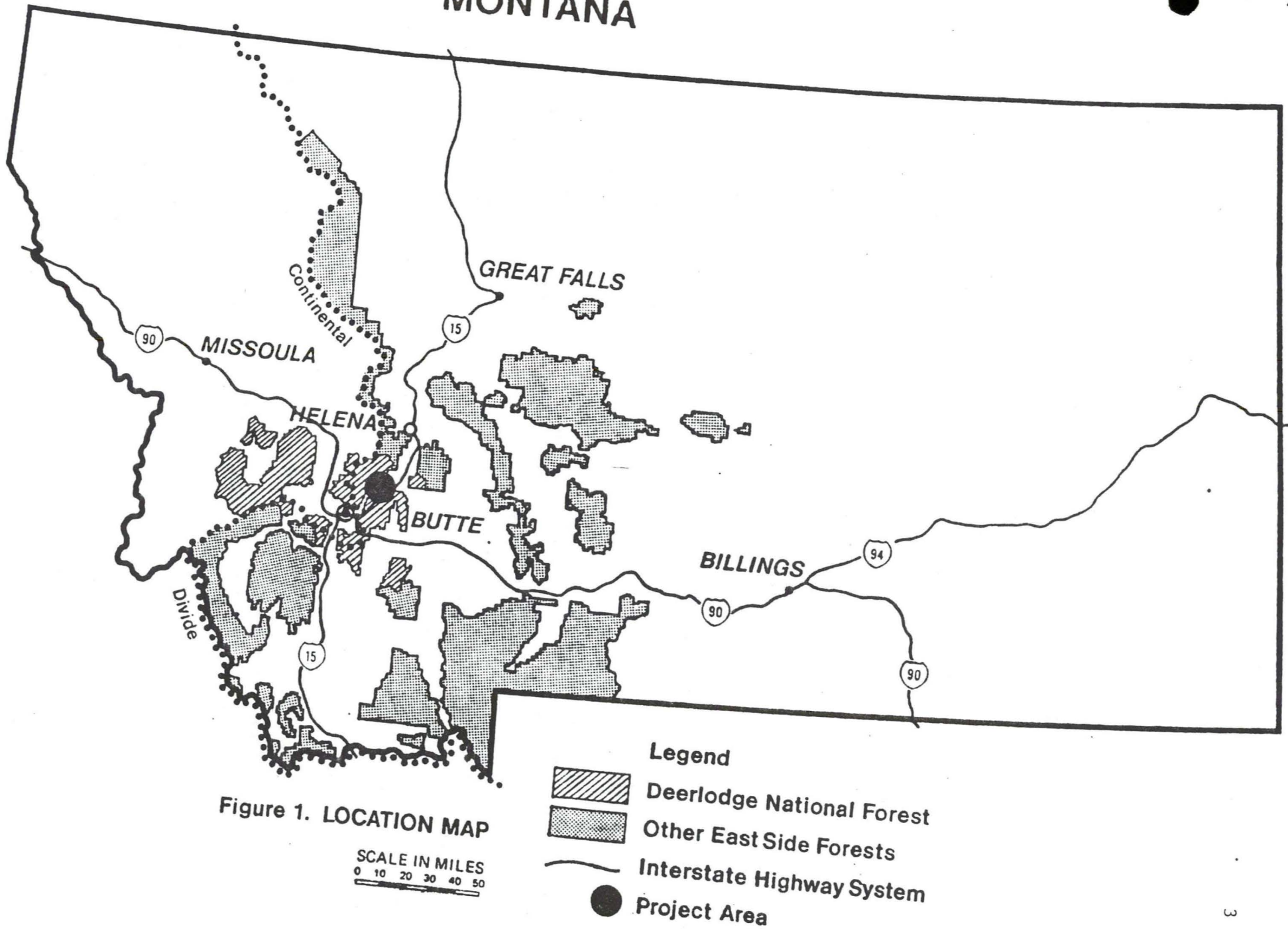
1) Douglas-fir encroachment in sagebrush/grass parks.

This situation comprised approximately 1000 acres in grassland or sagebrush/grassland parks being invaded by Douglas-fir (Fire Group 4, Fischer and Clayton 1983). Grass in these parks is a primary source of forage for cattle. These areas are also considered primary elk winter and spring range. The treatment objective was to utilized prescribed fire to reduce encroaching Douglas-fir (and sagebrush) and thereby increase herbaceous production and availability.

2) 1936 Galena Gulch wildfire.

This burned area is approximately 100 acres in size on north facing Psme/Caru and Psme/Arco h.t.'s (Fire Group 5). The area

# MONTANA



was logged in the mid 1930's, and followed by wildfire resulted in profuse aspen regeneration. After nearly fifty years the aspen and herbaceous forage are being crowded out by Douglas-fir and lodgepole pine. The objective in this situation would be to use a high intensity fire to kill competing conifers where sufficient fuel existed to carry a fire.

3) Second growth Douglas-fir.

Approximately 1500 acres are covered by this situation and include a mosaic of Psme/Caru, Psme/Arco, Psme/Fesc, Psme/Agsp h.t.'s and other closely related h.t.'s which support dense Douglas-fir generation (Fire Groups 4 and 5). Prior to the exclusion of fire these areas had an open park-like appearance. The bunchgrass h.t.'s apparently supported low density Douglas-fir that was largely confined to rocky sites where fuel was sparse. The presence of skeletal remains of sagebrush at the base of many Douglas-fir in this situation suggests that a succession sequence of bunchgrass to sagebrush/bunchgrass to Douglas-fir has occurred. The overall treatment objective in this situation is to reduce Douglas-fir growth and recreate a park-like condition. Areas not capable of carrying a fire would be retained as wildlife cover. Three variations of this situation were identified;

A) Dense Douglas-fir regeneration with sparse ground fuels.

It was concluded that application of prescribed fire to these sites as they existed was not practical due to the lack of fuel to carry a fire. Some areas of this type had an opportunity to increase ground fuel load by logging with the resultant slash carrying the fire.

B) Open Douglas-fir stands with fuel loads adequate to carry a fire. A fire prescription was to be designed for a low intensity surface fire to underburn the stand. Young Douglas-fir would be killed and litter removed.

C) Remnant aspen clones encroached by Douglas-fir. Aspen is seral on these moist sites and is being heavily impacted by the conifer growth. All merchantable Douglas-fir would be harvested or used for firewood. Remaining conifers and aspen were to be slashed to insure adequate fuel for a relatively high intensity fire to achieve an objective of aspen and shrub browse regeneration.

4) Douglas-fir encroachment on south-facing slopes.

This situation covered approximately 355 acres in a Psme/Agsp h.t. (Fire Group 4) in lower Galena Gulch. A lack of water and steep terrain restricts summer use by livestock and big game. Mule deer use the area extensively during the winter and early spring. Douglas-fir has migrated from its historical location in rocky ridges and outcrops onto more open areas that were formerly swept by fires. Mountain big sagebrush (*Artemisia tridentata* vaseyana), and antelope bitterbrush (*Purshia tridentata*) have also increased in the absence of fire. Both shrub species are currently being out-competed by the increasing amount of

Douglas-fir. Insect defoliation of the old bitterbrush plants is also contributing to that shrubs decline. The fire objective in this situation is to reduce conifer competition and rejuvenate the shrub population by using moderate intensity prescribed fires to create a varied age-class shrub/grassland mosaic.

These vegetation "situations" were later investigated and described in a more indepth manner in a publication by Gruell et al. (1986). The document includes discussions on the vegetative characteristics, successional trends, the role of fire, response potential of plants, and fire prescription considerations for each of six treatment opportunities representative of the Douglas-fir/grassland ecotonal area. The publication addresses problems 1 - 2 listed in this report introduction.

In addition to the USFS interdisciplinary team involved with the preliminary planning of the Galena Gulch Prescribed Fire Demonstration Project, consultation with Wildlife Biologists from the Montana State Department of Fish and Game provided important input. A big game mitigation plan was implemented to offset the temporary impacts of the various land management activities.

## Results and Discussion

Treatment and control vegetation transects were established within, or adjacent to, each treatment unit to monitor treatment induced changes. One growing season data was obtained prior to treatment to establish a baseline. Postburn monitoring was conducted each growing season following treatment. Because of budgetary constraints the vegetation monitoring program was terminated after the 1985 sampling period.

Three treatment transects were burned during the spring of 1983 (Units 1b). Because of various problems encountered with permittee grazing and small-sale timber contracts prescribed fires initially planned for fall 1983 and spring 1984 were rescheduled. Burning was conducted on these areas (Units 2a and 2b) during fall 1984. The three transects on units 1b have been monitored for four consecutive growing seasons (three following treatment). Data on the fire effects on these transects are summarized in this report. Transects established in Units 2a and 2b were not resampled in 1985 following treatment. Vegetal response of these units were noted during a walk-through evaluation at the end of the 1985 growing season.

### Units 1b, Spring Burns (1983)

#### Transects 1 and 2

Data from Transects 1 and 2 have been combined in this report. The two transects were placed in the same general area and plant community in a cross pattern and received similar treatments on the same date. Combined they provide a better sample of the postburn vegetal response. Vegetation is characterized by a Douglas-fir/rough fescue (Festuca scabellia) habitat type and is representative of treatment situation 1. This site is level to slightly rolling with thin skeletal soils.

Actual and calculated fuel and weather variables at the time of ignition on May 23, 1983 are presented in Table 1. This prescribed fire was typical of a relatively cool, low intensity fire that consumes areas of dry fuel and burns around sites with either little or moist fuel.

Table 1. Summary of environmental variables during ignition of Transects 1 and 2 (Unit 1b), Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1 (May 23, 1983; 1200 - 1500 hrs.).

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<u>Fuel Variables</u>	
Herbaceous Loading (T/ac, Mean $\pm$ 1SD)	.64 $\pm$ .20
Estimated Percentage of Live Herbaceous	5
Calculated Live Herbaceous Loading (T/ac) <sup>1</sup>	.02 - .04
Live Shrub Fuel Loading (T/ac) <sup>2</sup>	.57
Live Shrub Fuel Depth (Ft)	1.73
Calculated Mean Fuel Bed Depth (Ft) <sup>1</sup>	1.32
Calculated Range of Fuel Bed Depth (Ft) <sup>1</sup>	1.24 - 1.42
Calculated Mean Moisture of Extinction (%) <sup>1</sup>	27
Calculated Range of the Moisture of Extinction (%) <sup>1</sup>	26 - 29
Mean 1-Hour Timelag (Herbaceous) Moisture (%)	8
1-Hour Timelag (Herbaceous) Moisture Range (%)	7 - 8
Mean Live Herbaceous Moisture (%)	300
Mean Live Shrub Moisture (%)	153

<u>Weather Variables</u>	
Windspeed (Mean / Range in MPH)	3 / 0-5
Temperature (Minimum and Maximum in °F)	62 - 69
Relative Humidity (Minimum and Maximum in %)	17 - 24

<u>Soil Variables</u>	
Mean Soil Moisture (%)	53
Mean Percent Gravel	34

<sup>1</sup> Values calculated by the BEHAVE fire behavior prediction system (Burgan and Rothermel 1984).

<sup>2</sup> Value determined by the SAGE program for estimating sagebrush fuel and biomass (Bushey *et al.* 1985).

Fire behavior was characterized by average flame lengths of 2 feet in height (range of .5 to 3 feet) and rate-of-spread of 7 feet/minute (range 1 to 22 feet/minute) in the predominant shrub/grass fuel bed. Torching conifers were not considered representative fire behavior. Soil moisture during the prescribed fire was measured at 53% and reflected saturation from recent snowmelt. Percent gravel in the soil was measured at 34%. Approximately 51% of the surface area occupied by the transects were burned. Litter coverage was reduced by 19% at the end of the first postburn season (Table 2). Percent bareground coverage increased slightly from 2 to 7%, while coverage by bryophytes decreased from 8 to 7% following the treatment the first growing season. These features were not resampled during the 1984-1985 monitoring.

#### Conifer Response

Preburn conifer coverage, comprised exclusively of Douglas-fir, was reduced from 14 to 2% (Table 2, Figure 2). An 86% reduction in crown coverage was achieved by the end of the third growing season. Conifer mortality was initially high with 77% of the stems killed by the fire. This value only included conifers that were definitely killed or completely scorched. Any trees which had green foliage were classified as still living. Continuing increases in mortality were noted the second and third postburn seasons for a final 1985 value of 93% of the conifer stems killed. Trees that died during the second and third postburn seasons appear to have succumbed to stress induced by the amount of crown removed during treatment. Insect contributed mortality was restricted to the first growing season following treatment. Mortality has been consistent among all height classes. Approximately 88% of the stand basal area had been killed by the end of 1985.

The Douglas-fir remaining alive can be characterized as trees over 4.5 feet in height, they contributed little to initial stand basal area but tended to provide a large crown coverage on an individual tree basis. Most of the lower quarter of the original crown on these trees have been "pruned" by the treatment. The remaining Douglas-fir have exhibited continued active growth and it appears that on-site tree mortality has stabilized. It is expected that a slow seedling recruitment process will now resume the successional process until the next perturbation to the site.

#### Shrub Response

Coverage of shrubs, comprised mostly of mountain big sagebrush, decreased considerably following burning from 17 to 3% (Table 2, Figure 3). Sagebrush frequency had decreased by 21% at the end of the second growing season following treatment. That frequency value remained stable the third season. Mortality of the sagebrush following treatment was actually higher than the reduction in occurrence suggests. Mature stem frequency was reduced approximately 45% following the treatment and has remained constant for the three postburn seasons. Sagebrush seedling frequency has increased from 0% preburn, to 18% the first postburn season, then climbed to 24% the second season. Seedling frequency remained constant the third year. It has been demonstrated that germination of soil banked seed from mountain big sagebrush is stimulated by a light heat treatment (Hironaka *et al.* 1983). It is evident from the results of this study that either a heat stimulation, or wind-blown seed from nearby sagebrush stands have found the burned

Table 2. Selective summary of 1983 spring burn Transects 1 and 2 (Unit 1b) postburn data from the Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.

	Preburn 1982	1983	Change From Preburn (%)	1984	Change From 1983 (%)	1985	Change From 1984 (%)	Total Change From Preburn (%)
Litter (% Cover)	69	56	-19	NA		NA		-19
Mineral Soil (% Cover)	2	7	+250	NA		NA		+250
Bryophytes (% Cover)	8	7	-13	NA		NA		-13
Conifers (% Cover)	14	2	-86	2	0	2	0	-86
(No. of Stems)	107	25	-77	8	-68	7	-13	-93
(B.A., Ft <sup>2</sup> /ac)	8	1	-88	1	0	1	0	-88
Sagebrush (% Cover)	17	3	-82	3	0	3	0	-82
Herbaceous Production (lbs/ac)	572	754	+32	999	+33	1174	+18	+105

Figure 2. Changes in conifer percent cover and number of stems due to the 1983 spring prescribed fire treatment on Transects 1 and 2, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1 .

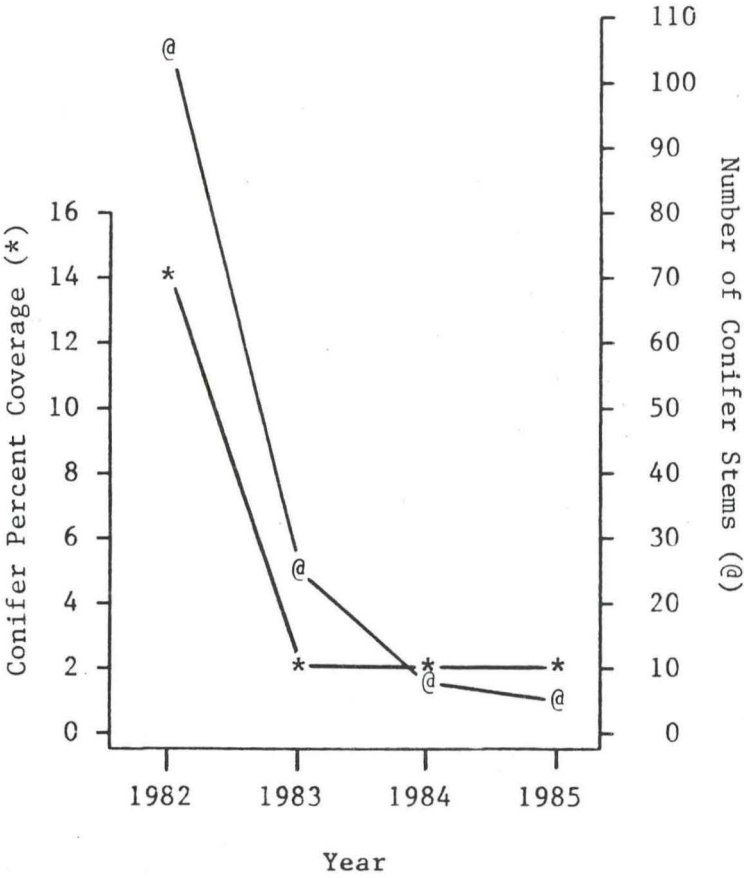
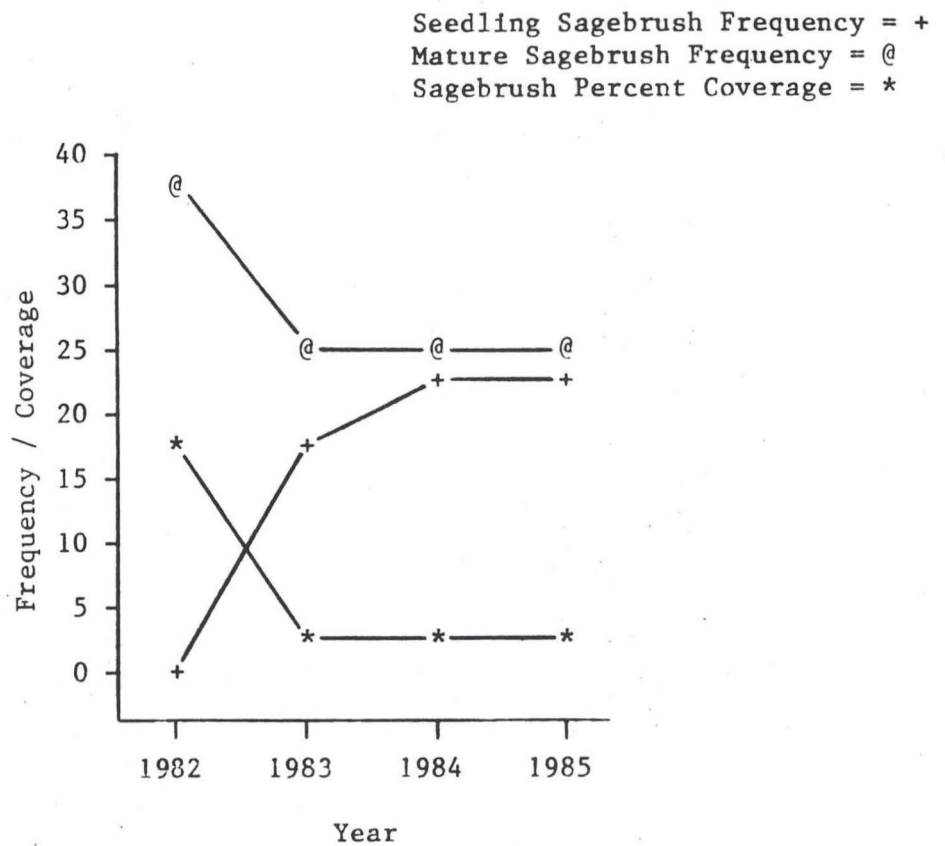


Figure 3. Changes in sagebrush percent cover and frequency due to the 1983 spring prescribed fire treatment on Transects 1 and 2, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.

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area suitable for establishment. Regeneration of the sagebrush has been concentrated on microsites that burned but appear to have been slightly more moist than surrounding areas. These microsites are in areas that previously had a high percent coverage of sagebrush or Douglas-fir and establishment is frequently in an area that was beneath this burned woody vegetation. Some seedlings on good sites away from the transects had attained 1 foot in height, a crown diameter of 10 inches and were flowering by the end of their third postburn season.

Spiraea (Spiraea betulifolia), squaw currant (Ribes cereum), and Arkansas rose (Rosa arkansana) contributed little to preburn coverage (less than 0.2%). Arkansas rose has resprouted but continues to contribute little to total shrub cover. Spiraea and squaw currant have both been eliminated along the transects but have resprouted on other nearby burned areas within the unit.

#### Grass and Forb Response

Herbaceous production for the transects has continued to increase each postburn growing season (Table 2, Table 3, Figure 4). Normalized treatment mean herbaceous productivity normalized to the control transect data shows a 128%, 165%, and 244% increase in production each consecutive postburn season over the preburn production value. This represents a change from approximately 572 mean preburn lbs/ac, to 1174 mean lbs/ac in 1985. The production level of the untreated control transects declined slightly in 1985, possibly being drought induced. These production values have been adjusted to take into account the approximate amount of forage removed by herbivores. Especially heavy grazing was noted on the burned areas, while frequently the controls were relatively ungrazed.

Most of the principal forage graminoids fluctuated little from their preburn condition in terms of their frequency of occurrence ( $\pm 5\%$ ). Idaho fescue (Festuca idahoensis) experienced a postburn decrease in frequency of 22.5% that peaked the second season and remained unchanged the third year. Rough fescue declined 17.5% the first postburn season, but responded with only a 5% reduction in frequency from preburn levels during the 1984 and 1985 growing seasons. Evidently bunches that had appeared dead the first postburn season greened-up by the second season. This is an assumption based on the observation that very little of the increase could be attributed to new rough fescue seedlings. No attempt had been made to individually mark what had appeared as dead plants in 1983 for a follow-up mortality/survival study. Kentucky bluegrass (Poa pratensis) was reduced in frequency by 27.5% the first postburn season and has remained near that level. Oatgrass (Danthonia intermedia) and June grass (Koeleria nitida) increased the first postburn season (7.5% and 40% respectively) and have remained essentially unchanged from that level in subsequent sampling seasons.

The majority of forb species showed little postburn change ( $\pm 5\%$ ) from their baseline levels. Pussey-toes (Antennaria microphylla) and sulphur eriogonum (Eriogonum umbellatum) had initially decreased in frequency the first postburn season (23% and 8% respectively). Both species have shown small increases in their frequency level indicating possible recovery from the treatment. An increase in occurrence had been noted for Rocky mountain draba (Draba crassifolia) of 23% which remained relatively unchanged the second postburn season. The frequency of the draba declined sharply from the peak postburn level to only an 9% increase over preburn levels in 1985. Dandelion (Taraxacum officinale)

Table 3. Pre and postburn herbaceous productivity from 1983 spring burn Transects 1 and 2 (Unit 1b) and controls, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.

	Preburn 1982	Postburn 1983 1984 1985			Control 1983 1984 1985		
Mean Productivity (lbs/ac)	572	754	999	1174	598	607	501
1 Standard Deviation from the Mean Productivity (lbs/ac)	180	218	720	582	124	119	143
Mean Productivity Normalized to Preburn Productivity (%) <sup>1</sup>	100	132	175	205	103	106	84
Normalized Mean Productivity Normalized to Control (%) <sup>2</sup>	100	128	165	244	100	100	100
No. of Sample Plots	52	108	108	108	40	40	40

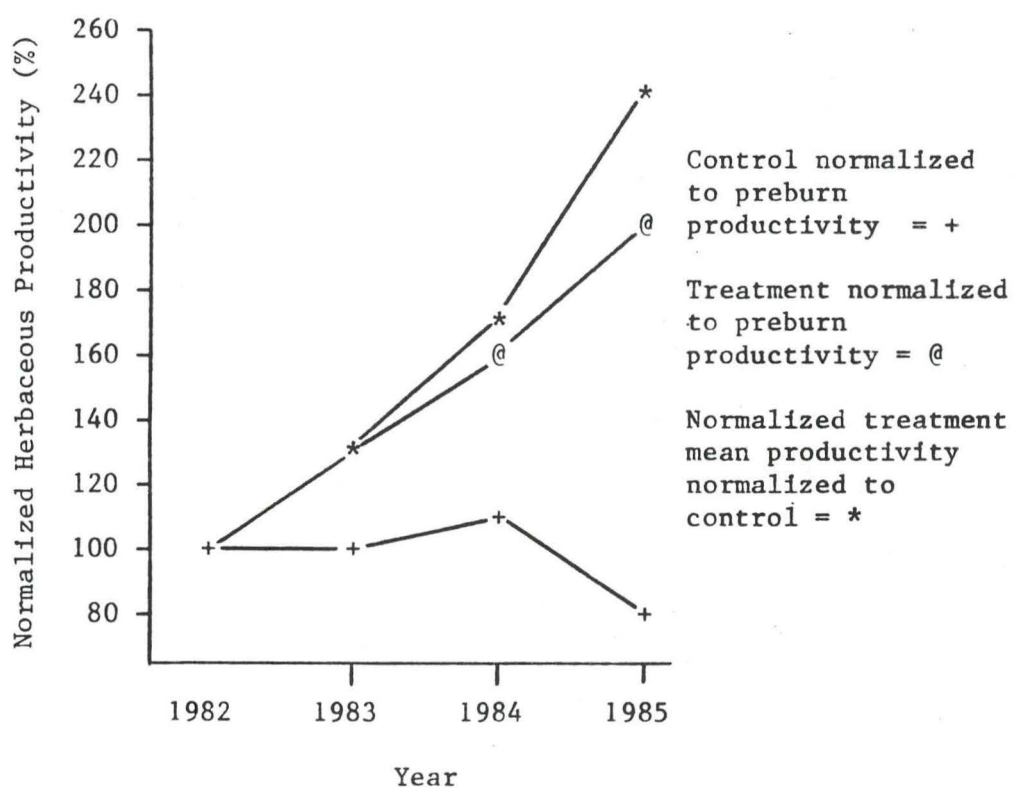
<sup>1</sup> Example of calculation of mean productivity normalized to preburn productivity.

$$\frac{754 \text{ lbs/ac (Postburn 1983)}}{572 \text{ lbs/ac (Preburn 1982)}} \times 100\% = 132\%$$

<sup>2</sup> Example of calculation of normalized mean productivity normalized to controls.

$$\frac{132\% \text{ (Normalized 1983 Postburn)}}{103\% \text{ (Normalized 1983 Control)}} \times 100\% = 128\%$$

Figure 4. Normalized herbaceous productivity for treatment and control Transects 1 and 2 (Unit 1b), Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.



increased in first year postburn frequency 50% over the preburn baseline value. Slight declines from this high level have been recorded in subsequent seasons (48% in 1984, and 43% in 1985).

Postburn composition of the herbaceous stratum has remained unchanged. Most herbaceous species have remained essentially unchanged in their frequency response to the fire treatment. Some temporary fluctuations in individual species populations have occurred and it is believed these changes were induced by the treatment. The same species showing treatment transect changes have shown no major fluctuations in frequency on the control transects. Changes in herbaceous productivity have also been induced by the treatment, with little change shown by the control transects.

### Transect 3

Transect 3 was located in the center of a gentle concave slope surrounded by rolling topography. Vegetation is characteristic of the Douglas-fir/rough fescue habitat type and was also representative of treatment situation 1. Douglas-fir was widely scattered through the unit, principally in the seedling and small sapling stages, but remained unrecorded by the transect data. This portion of Unit 1b was burned on May 5, 1983 and resulted in approximately 39% of the site surface receiving a fire treatment.

Fuel and weather data collected and calculated from the time of the burn are listed in Table 4. This prescribed fire was also a relatively cool, low intensity fire but was likely typical of prescribed fires in this fuel type conducted during this early time of year. Fire behavior was characterized by average flame lengths 3 feet in height (range 2 to 6 feet) and rate-of-spread of 10 feet/minute (range 3 to 24 feet/minute). Soil moisture measured prior to ignition was 33%, with a percent gravel composition of 22%. This prescribed fire caused a first season postburn decrease in cover by litter of 32%, and resultant increases in bareground (37%) and rock (56%) (Table 5).

### Shrub Response

Preburn shrub cover was composed entirely of mountain big sagebrush and treatment resulted in an initial postburn reduction of 89%. A small increase in shrub coverage occurred the second growing season. Coverage had stabilized by the end of the third postburn year. A total sagebrush canopy reduction of 88% was achieved (Table 5, Figure 5).

Frequency of occurrence of mature sagebrush stems decreased from 55% to 21% the first postburn season and has stabilized at approximately that level. Seedling establishment rose from 0% preburn to 5%, 13%, and 15% for each of the consecutive sampling seasons. The new sagebrush regeneration is on microsites similar to those conditions described for Transects 1 and 2.

### Grass and Forb Response

Normalized mean herbaceous production normalized to the control transect increased following treatment by 204%, 303% and 428% each new postburn season. This represents a change from an approximate preburn level of 395 mean lbs/ac to 1216 mean lbs/ac in 1985 (Table 5, and 6, Figure 6). These production values have also been adjusted to attempt to correct for the percentage of forage removed by herbivores. The transect had received

Table 4. Summary of environmental variables during ignition of Transect 3 (Unit 1b), Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1 (May 4, 1983; 1200 - 1600 hrs.).

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<u>Fuel Variables</u>	
Herbaceous Loading (T/ac, Mean $\pm$ 1SD)	.49 $\pm$ .11
Estimated Percentage of Live Herbaceous	5
Calculated Live Herbaceous Loading (T/ac) <sup>1</sup>	.02 $\pm$ .03
Live Shrub Loading (T/ac) <sup>2</sup>	.99
Live Shrub Fuel Depth (Ft)	1.90
Calculated Mean Fuel Bed Depth (Ft) <sup>1</sup>	1.67
Calculated Range of Fuel Bed Depth (Ft) <sup>1</sup>	1.64 - 1.72
Calculated Mean Moisture of Extinction (%) <sup>1</sup>	31
Calculated Range of Moisture of Extinction (%) <sup>1</sup>	31 - 32
Mean 1-Hour Timelag (Herbaceous) Moisture (%)	7
1-Hour Timelag (Herbaceous) Moisture Range (%)	5 - 18
Mean Live Herbaceous Moisture (%)	300
Mean Live Shrub Moisture (%)	115
<u>Weather Variables</u>	
Windspeed (Mean / Range in MPH)	4 / 1-7
Temperature (Minimum and Maximum in °F)	48 - 56
Relative Humidity (Minimum and Maximum in %)	17 - 24
<u>Soil Variables</u>	
Mean Soil Moisture (%)	32
Mean Percent Gravel	22

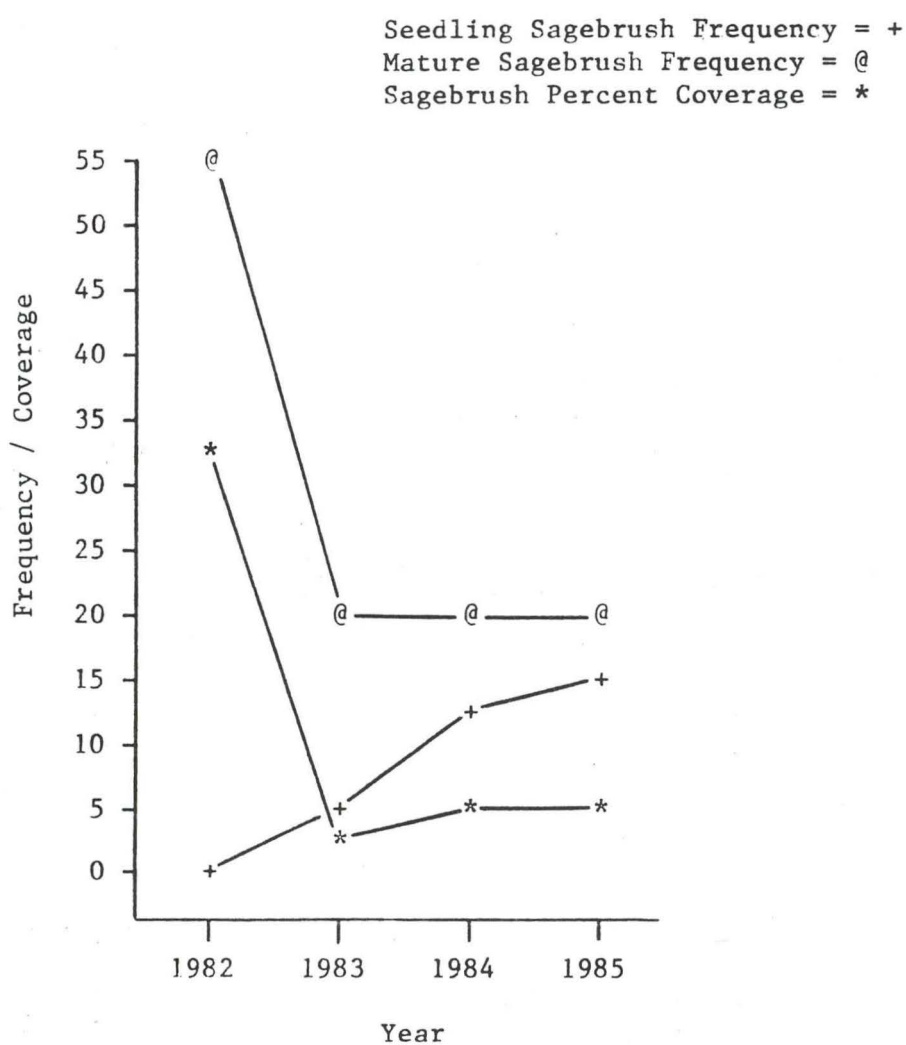
<sup>1</sup> Values calculated by the BEHAVE fire behavior prediction system (Burgan and Rothermel 1984).

<sup>2</sup> Value determined by the SAGE program for estimating sagebrush fuel and biomass (Bushey et al. 1985).

**Table 5.** Selective summary of 1983 spring burn Transect 3 (Unit 1b) postburn data from the Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.

	Preburn 1982	1983	Change From Preburn (%)	1984	Change From 1983 (%)	1985	Change From 1984 (%)	Total Change From Preburn (%)
Litter (% Cover)	72	49	-32	NA		NA		-32
Mineral Soil (% Cover)	11	18	+64	NA		NA		+64
Bryophytes (% Cover)	3	7	+133	NA		NA		+133
Conifers (% Cover)	0	0	0					0
(No. of Stems)	0	0	0					0
(B.A., Ft <sup>2</sup> /ac)	0	0	0					0
Sagebrush (% Cover)	32	3	-91	4	+33	4	0	-88
Herbaceous Production (lbs/ac)	395	660	+67	886	+34.	1216	+37	+208

Figure 5. Changes in sagebrush percent cover and frequency due to the 1983 spring prescribed fire treatment on Transect 3, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.



accidental heavy grazing the fall (September - October) of 1983, light grazing the fall of 1984, and moderate use in the summer (June - July) of 1985. Spring use of the burned site has been very heavy by elk. The resultant grazing pressure has probably had a depressant effect on the potential total herbaceous production.

Much of the initial postburn increase in production on this transect was by Richard's needgrass (Stipa richardsoni). Production of this species on the burned area started to decline the second postburn season and has continued in a downward trend since. This grass has rem

ained a minor component in terms of biomass on unperturbed sites. Both rough fescue and Idaho fescue declined in productivity the first postburn season but have shown large increases in subsequent seasons. All other grasses, and forbs in general, have shown steady biomass increases since treatment.

Data from the frequency plots have shown no major gains or losses ( $\pm 5\%$ ) among the graminoids or forbs along this transect. The minor changes that have occurred can be attributed to normal cycles of recruitment and mortality, and seasonal fluctuations.

#### Evaluation of Objectives for Unit 1b

The following were fire objectives for the 1983 spring burns (Unit 1b) on the Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest;

- 1) remove 80 - 100% of the encroaching Douglas-fir reproduction,
- 2) remove 60 - 80% of the encroaching sagebrush,
- 3) allow no more than 25% mortality of Idaho fescue and rough fescue.

In addition to these fire objectives, there was a specific land management objective; to improve the quality of forage for livestock and wildlife.

Fire objective 1 was met on Transects 1 and 2 the first growing season after treatment in terms of coverage, stem density and basal area. Increasing conifer mortality the second and third years has reinforced the successful completion of this goal. Because no conifers were present adjacent to Transect 3, a quantitative evaluation of this objective was not possible for that site. However, walk-through qualitative evaluations indicated at least an 80% mortality of Douglas-fir seedlings and saplings after the first growing season. Tree mortality has now stabilized, and a slow recruitment process on both areas will begin.

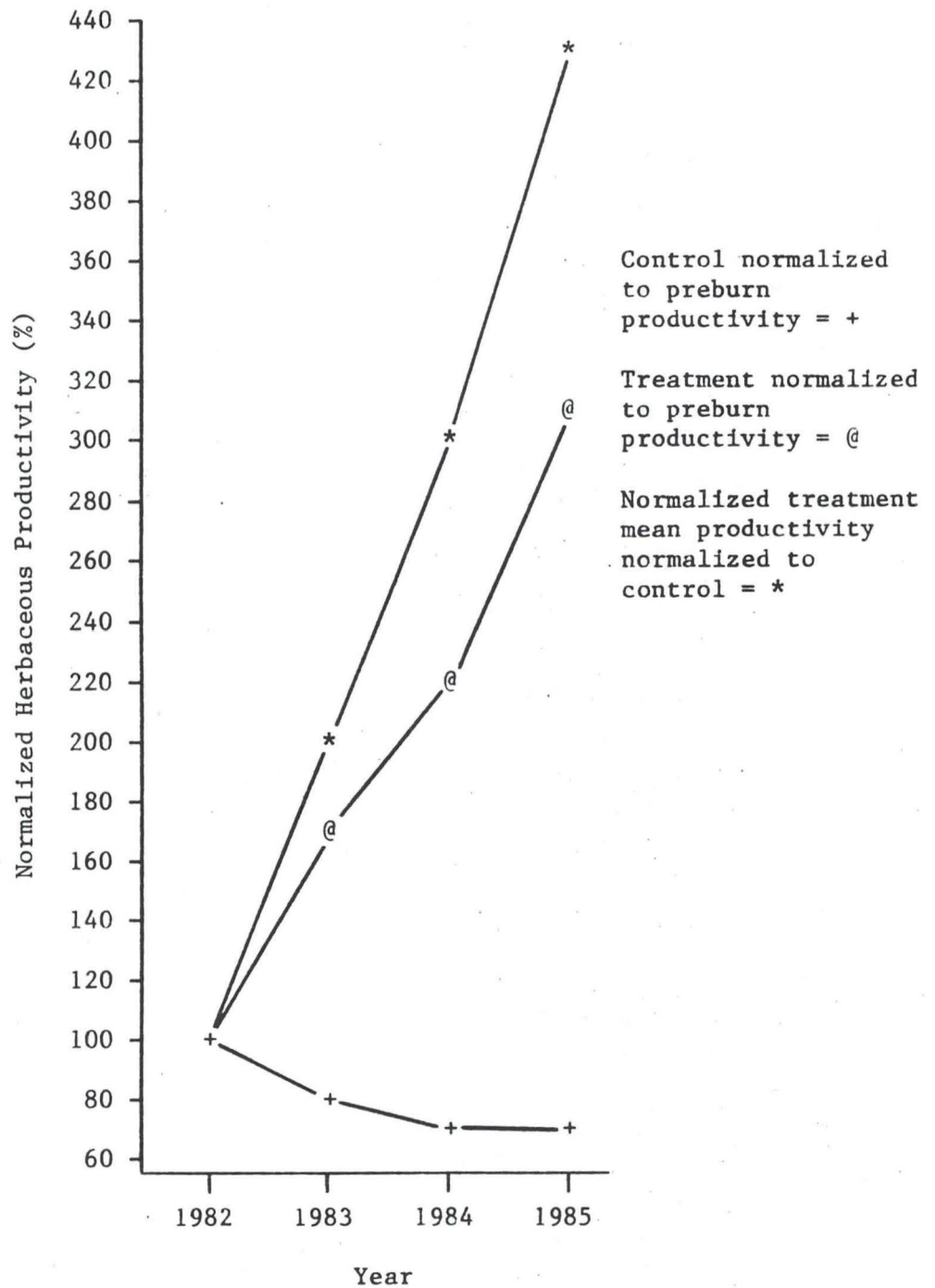
Objective 2 was clearly met in terms of reduction of sagebrush percent cover. This was accomplished on both transects the first growing season following treatment. The influx of sagebrush seedlings on burned microsites will make this a short term change. Seedling establishment following a low intensity fire is a potential result on any site dominated by mountain big sagebrush. It is expected that sagebrush coverage on these treatment transects will steadily increase and approach or attain preburn status in at least 10 - 15 years.

Mortality of both species of fescue remained below the level set in fire objective 3. Fire effects on these two grass species were more

Table 6. Pre and postburn herbaceous productivity from 1983 spring burn Transect 3 (Unit 1b) and controls, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.

Mean Species Productivity (lbs/ac)	Preburn	Postburn			Control		
	1982	1983	1984	1985	1983	1984	1985
<u>Agropyron spicatum</u>	35	177	140	218	42	39	45
<u>Carex</u> spp.	12	22	30	52	7	5	18
<u>Festuca idahoensis</u>	178	71	218	286	205	178	145
<u>Festuca scrabella</u>	139	45	228	420	36	29	32
<u>Koleria nitida</u>	28	30	56	52	26	31	25
<u>Stipa richardsoni</u>	2	306	137	93	4	3	2
Forbs	1	9	77	65	4	8	17
Mean Productivity (lbs/ac)	395	660	886	1216	324	293	284
1 Standard Deviation from the Mean Productivity (lbs/ac)	128	298	419	463	333	107	249
Mean Productivity Normalized to Preburn Productivity (%)	100	167	224	308	82	74	72
Normalized Mean Productivity Normalized to Control (%)	100	204	303	428	100	100	100
No. of Sample Plots	32	40	40	40	28	40	40

Figure 6. Normalized herbaceous productivity for treatment and control Transect 3 (Unit 1b), Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.



severe on Transects 1 and 2 than on Transect 3. This was likely due to the advanced phenological stage of the plants on Transects 1 and 2. Green-up was progressing at the time of both treatments, but new growth was considerably more advanced on May 24 (1 - 1½ inches) as compared to May 5 (¼ - ½ inch).

The quantity of available forage improved on both transect areas. Herbaceous production has continued to increase on the treated areas. Sagebrush and conifer removal has made this new forage more readily available for use by herbivores. Herbaceous production on these areas will likely peak within the next several years (assuming it has not already done so), then begin a steady decline as sagebrush cover increases. Quality of forage is very difficult to evaluate in a quantitative manner and was not attempted in this study. However the reaction of domestic cattle and wildlife to the burned sites would indicate that they have preferred the forage produced on these locations. Adjacent untreated forage experienced minimum use (0 - 25%) while treated areas consistently had concentrated grazing with heavy utilization (60 - 90%) each season evaluated. The heavy use during 1985 may have been accentuated by a very dry growing season. Elk that normally stay at higher elevations during August and September were observed grazing the burned units in the parks with the scattered livestock. It is believed the goal as listed in objective 4 has been met each of the seasons evaluated following treatment. Future consideration may be given to increasing the area of treatment if possible for better distribution of herbivores, especially during the first two postburn seasons.

#### Unit 2a, Fall Burn (1984)

Unit 2a was composed of two adjacent areas which required differing management techniques. The lower area was designated Clearcut Unit 2a, and above it was Encroachment 2a. Both units were on south facing slopes averaging approximately 30%. Each will be presented separately since, even though they were adjacent, they represented very different management strategies and received treatment on different dates.

##### Clearcut Unit 2a

This area was representative of treatment situations 3a and 3c, and was approximately 30 acres in size. A small timber sale was implemented by the District on 25 acres of the unit. The operator was to remove merchantable timber and slash the remaining conifers and aspen. The residue was to be distributed over the site creating a fuel load to carry the prescribed fire. Prior to slashing, the site would have been extremely difficult to burn. After the operator removed the timber he was interested in, the general public was allowed to cut and remove firewood for a limited time.

The fuel residue consisted of 49% lodgepole, 39% Douglas-fir, 16% aspen and 2% juniper (Juniperus scopulorum). A downed woody fuel inventory (Brown 1974, Brown et al. 1982) determined the clearcut fuel load as 21 tons/acre with an average fuel depth of 1 foot. Average duff depth was 1.8 inches.

The vegetation within the 25 acre clearcut is a mosaic of the Psme/Caru and Psme/Arco habitat types. Preburn herbaceous vegetation beneath the forest canopy was sparse due in part to tree induced shade

and a thick duff layer. Pinegrass was prominent only on the more moist microsites. The remaining 5 acres was Psme/Agsp habitat type with a large component of mountain big sagebrush. Vegetation transects were not established because the unit's timber was already being harvested.

Burning was conducted on September 18, 1984 during the early evening hours (1730 - 1830 hrs.). Fuel and weather data at the time of ignition are presented in Table 7. Strong winds (20+ MPH) traveled over the ridge top behind the unit, with lighter across slope winds on the fire. The upper level winds sheared the smoke column and directed it toward the opposing ridge. USFS crews were maintained on the unit during the daylight hours on the 19th and 20th for mop-up and perimeter patrol. A cold front started to bring light rains on the afternoon of the 21st, and by the 24th 2 - 5 inches of snow had fallen.

A cost summary for burning this unit was prepared by the District. Costs included in the summary were wages, vehicle mileage and supplies. Burn plan preparation and line building were not considered District expenses and were not included in the summary. Total District cost was determined to be \$150.48/acre for the 30 acre unit.

#### Evaluation of Objectives for Clearcut Unit 2a and Vegetal Response

Land management objectives for this portion of unit 2a were listed in the Burn Plan as;

- 1) rejuvenate and increase the productivity of aspen, sprouting shrubs, and herbaceous vegetation by the removal of conifer encroachment and competition for the beneficial use by livestock and wildlife,
- 2) The development of a mineral soil seedbed for seedling establishment by off-site, airborne seed of pioneer trees and shrubs; and for the establishment of on-site, long and short term viability (seed banking) shrubs for livestock and wildlife.

Trees and shrubs that occurred on the site and which are classified as sprouters were antelope bitterbrush, buffaloberry (Shepherdia canadensis), chokecherry (Prunus virginiana), rose (Rosa spp.), Scouler willow (Salix scouleriana), serviceberry (Amelanchier alnifolia), spiraea, snowberry (Symphoricarpos albus, S. occidentalis), and squaw currant. Off-site, airborne seed species were aspen, cottonwood (Populus deltoides, P. trichocarpa), and Scouler willow. Seed banking shrubs either already present or determined to be possibly present were antelope bitterbrush, buffaloberry, chokecherry, evergreen ceanothus (Ceanothus velutinus), rose, serviceberry, spiraea, and squaw currant (Noste and Bushey 1985).

To accomplish the above land management objectives the following fire objectives were developed;

- 1) to reduce the 0 - 1/4 inch fuel by 70%, 1/4 - 1.0 inch fuel by 30%, and the 1.0 - 3.0 inch fuel by 15%,
- 2) to expose 50% or more of the unit to mineral soil.

A walk-through evaluation of Clearcut Unit 2a the day after the prescribed fire was conducted by E.M. "Sonny" Stiger (USFS Zone Fuel Specialist), M.S. Peila (USFS Asst. Zone Fuel Specialist) and C.L. Bushey to determine whether the fire objectives had been met.

Table 7. Summary of environmental variables during ignition of Clearcut Unit 2a, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1 (September 18, 1984; 1730 - 1830 hrs.).

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<u>Fuel Variables</u>	
Down Woody Loading (T/ac)	21
Fuel Bed Depth (Ft)	1
Duff Depth (Inches)	1.8
Mean 1-Hour Timelag (Herbaceous) Moisture (%)	14
1-Hour Timelag (Herbaceous) Moisture Range (%)	5 - 22
Mean Live Herbaceous (Pine grass, <u>Calamagrostis rubescens</u> ) Moisture (%)	29
Mean Live Shrub (Sagebrush) Moisture (%)	75
Mean Douglas-fir Needle Moisture (%)	113
Mean Upper Duff Moisture (%)	7
Mean Lower Duff Moisture (%)	16
<u>Weather Variables</u>	
Windspeed (Mean / Range in MPH)	7 / 5 - 11
Temperature (Minimum and Maximum in °F)	72 - 74
Relative Humidity (Minimum and Maximum in %)	65 - 66

Overall observations determined that the fire had successfully reduced the downed woody fuel and duff to levels below those stated in the fire objectives.

At the end of the 1985 growing season I again conducted a walk-through evaluation to determine the fire effects on the vegetation. In many respects it is still too early to accurately say if the land management objectives will be met, but certain indications of future trends were evident.

Aspen sprouts were few and widely scattered on east and southeast facing aspects. The poor aspen resprouting may be due in part to the delay experienced in prescribed burning of the site. Two growing seasons of aspen suckering had already occurred prior to the fire treatment. This time period would have allowed extensive use of the carbohydrate root reserves in the severed aspen clones. Also most aspen suckers are produced within the first two seasons following cutting (Schier *et al.* 1985). The depletion of food reserves and the destruction of all first and second year suckers may have been detrimental to the strength of the clones. Each year the suckers were also subjected to heavy grazing by wildlife. Nearly all aspen sprouts observed in 1985 had also been grazed. Management alternatives to help remedy this situation on future units might be to slash the adult aspen clones no more than 1 growing season prior to burning. If the aspen is a small component of total fuel load it might be possible to cut the adult boles only 1 - 2 months before burning. Also the treatment on the same schedule of multiple units of this type, or the treatment of single units with larger acreages would help to alleviate the wildlife pressure on the new regrowth. It does not appear at this time that the objective of increased aspen regeneration following burning will be achieved.

Resprouting by shrubs on the unit was better than expected. Initial low expectations were due to the decadent condition much of the shrub community was in before the unit was slashed and burned. Much of this regrowth has taken place in, or adjacent to rock outcrops and moist microsites. All shrub species except buffaloberry were observed to be resprouting in dense localized areas. Buffaloberry was initially uncommon on the site and new growth may have been overlooked. Rapid expansion of shrub clones can be expected as they take advantage of the temporary competitive freedom now available.

Deciduous tree and shrub seedlings were still very small and difficult to distinguish as to species at this early stage. Evergreen ceanothus, a shrub not evident to the casual observer before the fire treatment and an easily identifiable seedling, was abundant throughout the Psme/Caru and Psme/Arco habitat types first season postburn. It was estimated that from 100 - 100,000 ceanothus seedlings per acre had germinated and survived the first growing season where no adult ceanothus were previously apparent. These high seedling counts will decline dramatically as the shrub matures, but should be more than adequate to establish a healthy population. Antelope bitterbrush seedlings were also observed, but restricted to scattered locations in the Psme/Agsp habitat type.

Preburn herbaceous productivity, though not measured, was observed as sparse and patchy in occurrence. One year after the prescribed fire treatment the herbaceous layer was still poorly developed. It will probably remain so for several years to come. The few areas where grass had been present during preburn conditions were lush, bright green and

expanding into adjacent burned areas during 1985. This inspite of an on-going drought during most of the growing season. Nearby unburned herbaceous material was brown and dormant and exhibited little new growth. Patches of the "weedy" biennial plant musk thistle (Carduus nutans) were expanding into burned areas from roads and severe logging disturbed sites where they had previously been established. This plant will continue to expand its population for several years if left unsprayed.

Given sufficient time (3 - 5 years postburn) the tree, shrub and herbaceous establishment and productivity objectives for the clearcut area will likely be met. With the new growth soon to be abundantly available, this site will provide numerous advantages to both livestock and wildlife over what had formerly been available on the relatively sterile lands beneath this dry site conifer overstory.

#### Encroachment Unit 2a

This 110 acre unit was a long, narrow grass park with dense encroachment by mountain big sagebrush and Douglas-fir. It was representative of treatment situations 1, 3a and 3b. The lowest elevation approached by the unit was 5860 feet with the upper boundary at approximately 6000 feet. Habitat types for the area were classified as a mosaic of Psme/Fesc and Psme/Caru.

Over half of the unit contained dense stands of Douglas-fir. Conifer coverage ranged from a high of 78% in a small area of mature conifers, to 18% in sagebrush/grass parks. Areas of dense conifer encroachment averaged 63% crown coverage (Table 8). Conifer density of stems less than 10 inches DBH (most of which were under 2 inches DBH) ranged from 240 to 1257 trees/acre. Trees over 10 inches DBH ranged from 140 stems/acre in the sagebrush/grass parks to 548 stems/acre within the dense encroachment stands. Much of the Douglas-fir, and especially the areas of dense encroachment, were in various stages of defoliation by western spruce budworm (Choristoneura occidentalis).

Sagebrush coverage ranged from a high of 32% (average 21%) in the sagebrush/grass parks, to 1% beneath the dense conifer encroachment. In the mature conifer stands sagebrush was totally absent. This progression showed the rapid decline in sagebrush coverage with increases in conifer coverage.

Herbaceous fuels had greened-up slightly from the earlier precipitation received on September 21 - 23. Most of the green-up occurred in areas with conifer encroachment or in the Psme/Caru habitat type. These areas were either moist microsites to begin with, or due to reduced exposure had soils and fine fuels that dried less rapidly.

Ignition of the unit was on October 3, 1984 during the afternoon (1300 - 1630 hrs.). Fuel loads and other pertinent data during ignition are listed in Table 9. Most of the fire activity was in the sagebrush/grass parks during peak periods of wind activity. At these times fire behavior was rated as moderate with flame lengths averaging 4 feet in height and rate-of-spread between 10 - 15 feet/minute. Behavior dropped rapidly with diminished winds. Dryer portions of the dense Douglas-fir encroachment burned and consumed the conifer crowns. The majority of the encroachment areas supported a creeping fire with little basal char or crown scorch impact on the trees. The Psme/Caru habitat type were able to sustain  $\frac{1}{2}$  - 1 foot flame heights along the habitat edges. These fires were either quickly reduced to smoldering or

Table 8. Selective summary of the preburn data from Encroachment Unit 2a, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1.

	Sagebrush/grass Park with Douglas-fir Encroachment	Dense Douglas-fir Encroachment	Mature, Open Douglas-fir Stand
Litter (% Cover)	44	87	45
Mineral Soil (% Cover)	46	4	4
Bryophytes (% Cover)	1	1	2
Conifers (% Cover)	18	63	78
(Density, of stems less than 10 inches DBH/ac)	290	240	1257
(Density, of stems greater than 10 inches DBH/ac)	140	548	282
(B.A., Ft <sup>2</sup> /ac)	17	29	227
Sagebrush (% Cover)	21	1	0
Herbaceous Production (lbs/ac)	426	136	205

Table 9. Summary of environmental variables during ignition of Encroachment Unit 2a, Galena Gulch Prescribed Fire Demonstration Area, Deerlodge National Forest, USFS Region 1 (October 3, 1984; 1300 - 1630 hrs).

Fuel Variables	Sagebrush/grass		
	Park with Douglas-fir Encroachment	Dense Douglas-fir Encroachment	Mature, Open Douglas-fir Stand
Herbaceous Loading (T/ac, Mean $\pm$ 1SD)	2.2 $\pm$ 2.1	4.7 $\pm$ 1.7	2.3 $\pm$ 1.1
Estimated Percentage of Live Herbaceous	5	30	60
Calculated Live Herbaceous Loading (T/ac) <sup>1</sup>	.0 - .02	.9 - 1.9	.7 - 2.0
Live Shrub Loading (T/ac) <sup>2</sup>	0.9	0.0	0.0
Live Shrub Depth (Ft)	2.3	0.0	0.0
Duff Depth (Inches, Mean $\pm$ 1SD)	0 $\pm$ 0	.82 $\pm$ .80	.72 $\pm$ .44
Down Woody Fuel Load (T/ac)			
0 - ¼ Inch	0.0	0.26	0.21
¼ - 1 Inch	0.0	1.14	1.20
1 - 3 Inch	0.0	1.58	1.09
3+ Inch	0.0	0.00	0.62
Mean/Range of 1-Hour Timelag (Herbaceous) Moisture (%)	8/ 6-10	10/ 8-12	11/ 8-21
Mean/Range of Live Herbaceous Moisture (%)	30/ 19-38	87/ 81-96	102/ 62-141
Mean/Range of Live Shrub (Sagebrush) Moisture (%)	91/ 90-91		
Mean Duff Layer Moisture (%)		52	69
Mean Douglas-fir Needle Moisture (%)	117	123	
<u>Weather Variables (for the entire unit)</u>			
Windspeed (Mean / Range in MPH)		4/ 2-6	
Temperature (Minimum and Maximum in °F)		63 - 71	
Relative Humidity (Minimum and Maximum in %)		32 - 44	
<u>Soil Variables</u>			
Mean Soil Moisture (%)	17		
Mean Percent Gravel	40		

<sup>1</sup>Values calculated by the BEHAVE fire behavior prediction system (Burgan and Rothermal 1984).

<sup>2</sup>Value determined by SAGE program for estimating sagebrush fuel and biomass (Bushey et al. 1985).

self-extinguished as they attempted to penetrate the habitats moist ground fuels. Approximately 80% of the sagebrush/grass park areas were burned, only 35% of the encroachment areas, and approximately 3% of the surface beneath the mature Douglas-fir stands. Mop-up activities were completed the day of the burn.

A cost summary prepared by the Jefferson Ranger District for Encroachment Unit 2a included the same line items as the summary prepared for the clearcut unit. Total cost for the Encroachment Unit 2a was determined to be \$56.24/acre for the 110 acre unit.

#### Evaluation of Objectives for Encroachment Unit 2a and Vegetal Response

Land management objectives for this unit were to remove sagebrush and conifer encroachment, and to rejuvenate grass (including increasing Idaho fescue and bluebunch wheatgrass productivity by 100%) and browse species for livestock and wildlife. To obtain these resource goals, fire objectives were established and included;

- 1) remove 80% or more of the Douglas-fir reproduction,
- 2) remove 60% or more of the encroaching sagebrush,
- 3) prevent no more than 25% long term mortality of Idaho fescue.

At the end of the 1985 growing season a walk-through evaluation of this burned area was completed for an initial inspection of postburn vegetal results. Transects previously established were not reread because of ending involvement in the demonstration project and a lack of subsequent data. Fire objective 1 was met only within the sage/grass parks. From a distance it would appear to the casual observer that the fire had also killed most of the Douglas-fir in the encroachment areas as the crowns on these trees were almost uniformly red. On closer examination it could be determined that the mortality was not fire induced, but was more likely caused by the western spruce budworm epidemic. Approximately 85% of the conifer stems in the dense encroachment areas appeared dead. Of this percentage, less than 5% of the mortality could be attributed to the fire. Fire objective 2 does appear to have been achieved, with small scattered areas of dense sagebrush still remaining. Very little grass mortality appeared to have occurred and it is likely that fire objective 3 was also met. Most grass mortality was in areas disturbed by line construction and mop-up activities. Grass productivity goals as referred to in the management objectives did not appear to have been met the first postburn growing season. Productivity appeared to be visibly reduced from the previous season and this was probably due to the droughty conditions in 1985. Considerable relatively fresh deer, elk and cattle droppings within the burn unit indicated extensive use of the area.

#### Conclusions

This study has clearly shown that eastside rough fescue grasslands that have been severely encroached upon by mountain big sagebrush and/or Douglas-fir can have a substantial response of herbaceous productivity following prescribed burning. Areas with marginal or stagnated timber production can also be rejuvenated for increased livestock and wildlife use. Prescribed fire was successfully used to reduce sagebrush and

conifer cover in several "treatment situations" and revert those areas to an earlier, more productive successional stage.

In addition to the fire effects portion of the study, information on the identification of prescribed fire opportunities was gathered. This information can aid in site selection and the achievement of fire and land management objectives.

Problems did occur during this project, as they will with all projects. Most of these problems centered on scheduling difficulties created by weather or misunderstandings with permittees and contractors. None of these problems proved insurmountable. Each solution to a difficulty improves upon the next project, and will make a similar job easier for future generations of land managers. The experienced gained in coping with the problems should lead to more effective operations leading up to and including the prescribed burning.

It is recommended that future prescribed fires in vegetation of this type be implemented on larger land units than was feasible in this particular demonstration project. These larger units can be more easily designed to use natural and topographic fuel barriers and will reduce the cost on a per acre basis. Larger units will also help disperse postburn animal impacts. Another recommendation is to establish long term management plans which incorporate the scheduled repeated use of prescribed burning of large acreages with the objective of maintaining a mosaic of successional stages. In this manner the Forest resource objectives for wildlife and livestock management can be better meet.

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